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Dated this 18th day of January 2005

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[TITLE OF THE INVENTION] Operation and Maintenance Planning Aiding System for Power Generation Installation

[CLAIMS]

1. An operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and connected via communication networks, the service center obtains plant data from the plurality of power generation units via the respective communication networks, for the every plurality of power generation units calculates power generation efficiency for the concerned power generation units in real time by making use of the obtained plant data and design data of the concerned power generation units and prepares operation and maintenance plans for the respective power generation units based on the calculated power generation efficiency.

2. An operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and connected via communication networks, the service center obtains plant data from the plurality of power

generation units via the respective communication networks, for the every plurality of power generation units estimates process values in a machine and apparatus model by making use of the obtained plant data, determines deviation values between the estimated values and measured values, calculates from the determined deviation value a cost of economical loss caused by a power generation efficiency reduction of the concerned power generation unit, and prepares operation and maintenance plans for the respective power generation units through comparison between the calculated cost of economical loss and a cost relating to exchange of the machine and apparatus and the parts thereof in the concerned power generation unit.

3. An operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and connected via communication networks, the service center obtains plant data from the plurality of power generation units via the respective communication networks, for the every plurality of power generation units calculates remaining life time of the machine and apparatus and the parts thereof in the concerned power generation unit by making use of the obtained plant data and prepares operation and maintenance

plans for the respective power generation units by determining exchange time of the machine and apparatus and the parts thereof in the concerned power generation unit based on the calculated remaining life time thereof.

4. An operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and connected via communication networks, the service center obtains plant data from the plurality of power generation units via the respective communication networks, for the every plurality of power generation units calculates remaining life time of the machine and apparatus and the parts thereof in the concerned power generation unit by making use of the obtained plant data, compares the calculated remaining life time with remaining life time of the machine and apparatus in the power generation unit determined in the other power generation unit, modifies the operation condition for the machine and apparatus and the parts thereof so as to enhance economy and prolong or shorten the remaining life time of the machine and apparatus and the parts thereof in the concerned power generation unit, thereby, prepares the operation and maintenance plans for the respective power generation

units.

5. An operation and maintenance planning aiding system for a power generation installation of any one of claims 1 through 4, wherein the service center stores in a data base failure histories of the machine and apparatus or the parts thereof in the plurality of power generation units, calculates a failure probability of the machine and apparatus or the parts thereof by making use of the failure histories stored in the data base, and prepares an operation and maintenance plan for each of the power generation units in view of the calculated failure probability.

6. An operation and maintenance planning aiding system for a power generation installation any one of claims 1 through 4, wherein the service center stores in a data base manufacturers of the machine and apparatus or the parts thereof in the plurality of power generation units and superiority with regard to reliability and maintenance capacity of the manufacturers and prepares an operation and maintenance plan for each of the power generation units in view of the superiority of the manufacturers stored in the data base when evaluating the machine and apparatus or the parts thereof.

7. An operation and maintenance planning aiding system for a power generation installation any one of claims 1 through 4, wherein the service center obtains the plant data for every plurality of the power generation unit in a predetermined time interval.

8. An operation and maintenance planning aiding system for a power generation installation comprising: a power generation unit, means for storing plant data at a desired timing of the power generation unit, means for storing design data of the power generation unit and means for calculating a power generation efficiency based on the stored plant data and design data.

9. An operation and maintenance planning aiding system for a power generation installation comprising: a power generation unit, means for storing plant data at a desired timing of the power generation unit, and means for evaluating the performance of the power generation unit based on an estimated process value estimated on a machine and apparatus model by making use of the plant data and the actually measured process value from the plant data.

10. An operation and maintenance planning aiding system for a power generation installation comprising:

a power generation unit, means for storing plant data at a desired timing of the power generation unit, means for calculating remaining life time of the power generation unit or the parts of the power generation unit from the plant data, and at least one of means for presenting exchange timing of the power generation unit or the parts of the power generation unit based on the calculated remaining life time and means for presenting an operation condition of the power generation unit based on the calculated remaining life time.

11. An operation and maintenance planning aiding method for a power generation installation including a power generation unit comprising: a step of storing plant data at a desired timing of the power generation unit, a step of storing design data of the power generation unit and a step of calculating a power generation efficiency based on the stored plant data and design data.

12. An operation and maintenance planning aiding method for a power generation installation including a power generation unit comprising: a step of storing plant data at a desired timing of the power generation unit, and a step of evaluating the performance of the power generation unit based on an estimated process

value estimated on a machine and apparatus model by making use of the plant data and the actually measured process value from the plant data.

13. An operation and maintenance planning aiding method for a power generation installation including a power generation unit comprising: a step of storing plant data at a desired timing of the power generation unit, a step of calculating remaining life time of the power generation unit or the parts of the power generation unit from the plant data, and at least one of steps of presenting exchange timing of the power generation unit or the parts of the power generation unit based on the calculated remaining life time and of presenting an operation condition of the power generation unit based on the calculated remaining life time.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF THE INVENTION]

The present invention relates to an operation and maintenance planning aiding system for a power generation installation, and, in particular, relates to an operation and maintenance planning aiding system for a power generation installation, in which a service center is provided which manages operation and

maintenance of a plurality of power generation units and prepares an operation and maintenance plan for respective power generation units by making use of plant data obtained from the respective power generation units through a communication network.

[0002]

[CONVENTIONAL ART]

Generally, many electric power generation companies, which operate electric power generation business, hold a plurality of power generation units, and, in order to manage the power generation amount of these power generation units as a whole, comprise respective power generation systems provided with a power supply command center (central supply) for every electric power generation company. In such power generation system the power supply command center assigns and adjusts the power generation amount for every power generation unit in response to power demand from consumers and each of the power generation units performs an operation while maintaining and adjusting the power generation amount assigned by the power supply command center. In such instance, the power supply command center prepares, in view of enhancing economy, an operation plan of the concerned power generation system so as to minimize fuel cost used in the power generation units, in that so as to maximize power generation efficiency as well as

prepares, in view of putting priority on environment protection, so as to keep the exhaust gas amount such nitrogen oxides and carbon dioxides exhausted from the power generation units within an allowable range.

[0003]

Now, the characteristics with regard to the power efficiency and the exhaust gas amount which are used as references for the operation planning vary greatly depending on kinds of fuel used and power generation methods. With regard to fuels, in case of a thermal power generation many kinds of fuels such as coal, petroleum and natural gas can be used, therefore, depending on the kind of fuels used, not only the power generation amount per unit fuel cost but also the amount and contents of the exhaust gas vary greatly. Further, with regard to power generation methods, the constitutions of machines and apparatuses of themselves such as power generation by a steam turbine, power generation by a gas turbine and a combined power generation combining thereof affect greatly to their power generation efficiency. The power supply command center stores and preserves plant data (data representing the plant characteristics) obtained from these power generation units for every power generation unit, and uses these plant data when preparing operation plans for respective power generation units.

[0004]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

In the above referred to conventional power generation system, although the power supply command center stores and preserves the plant data for every power generation unit, these plant data were limited to the plant data at comparatively early stage of the respective power generation units such as design values and those at the operation starting period of the power generation plants, however, these plant data vary gradually depending on passage of time, therefore, it was difficult to prepare operation plans based on the current plant characteristics of the respective power generation units if only by making use of these plant data.

[0005]

Further, the above referred to conventional power generation system, since the machines and apparatuses such as a gas turbine constituting the power generating unit are always exposed to a high temperature, if load variation to the machines and apparatuses is frequently and repeatedly caused, deterioration of the machines and apparatuses due to thermal fatigue rapidly advances. For this reason, even if a fully economic operation which simply minimizes fuel cost for respective power generation units is employed, when the load variation to the

machines and apparatuses is repeated, the life time of the machines and apparatuses is shortened to quicken exchange time thereof, the total cost for the respective power generation units necessary for the plant operation including the maintenance cost is not necessarily minimized.

[0006]

Further, in the above referred to conventional power generation system, even if a plurality of power generation units having a high power generation efficiency are positively selected for the operation, when a provability of failure of the machines and apparatuses and the parts thereof constituting the power generation unit concerned is high, an unplanned outage is caused by a failure occurrence in the machines and apparatuses and the parts thereof which possibly causes an economic loss, therefore, even when an operation plan for a plurality of power generation units is prepared only based on fuel cost, the resultant cost was not necessarily minimized.

[0007]

The present invention has been achieved in view of the above technical background, and an object of the present invention is to provide an operation and maintenance planning aiding system for a power generation installation in which an operation plan for a plurality of power generation units is prepared by

making use of actual plant data and based on total judgement including a variety of circumstances of the machines and apparatuses and the parts thereof in the power generation units.

[0008]

[MEASURES FOR SOLVING THE PROBLEMS]

A first aspect of the present invention is to provide an operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and connected via communication networks, the service center obtains plant data from the plurality of power generation units via the respective communication networks, for the every plurality of power generation units calculates power generation efficiency for the concerned power generation units in real time by making use of the obtained plant data and design data of the concerned power generation units and prepares operation and maintenance plans for the respective power generation units based on the calculated power generation efficiency.

[0009]

According to the first aspect of the present invention, since the operation and maintenance plans for the respective power generation units are prepared in the service center based on the power generation

efficiency evaluated and calculated in real time, a secular change and a performance degradation due to failure occurrence for the respective power generation units can be taken into account, thereby, the operation cost thereof can be reduced in comparison with the conventional power generation system in which the operation and maintenance plans for the respective power generation units are prepared by making use of the plant data.

[0010]

A second aspect of the present invention is to provide an operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and connected via communication networks, the service center obtains plant data from the plurality of power generation units via the respective communication networks, for the every plurality of power generation units estimates process values in a machine and apparatus model by making use of the obtained plant data, determines deviation values between the estimated values and measured values, calculates from the determined deviation value a cost of economical loss caused by a power generation efficiency reduction of the concerned power generation unit, and prepares operation and maintenance plans for the respective

power generation units through comparison between the calculated cost of economical loss and a cost relating to exchange of the machine and apparatus and the parts thereof in the concerned power generation unit.

[0011]

According to the second aspect of the present invention, when preparing the operation and maintenance plans for the respective power generation units in the service center based on the power generation efficiency evaluated and calculated in real time, since the cost of economical loss due to the performance degradation is calculated from the deviation value between the process value estimated with the machine and apparatus model and the measured value, the cost of economical loss is compared with the cost relating to the exchange of the machine and apparatus and the parts thereof and the operation and maintenance plan of the respective power generation units are prepared by making use of the comparison result, the total cost for the operation and maintenance can be reduced.

[0012]

A third aspect of the present invention is to provide an operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and

connected via communication networks, the service center obtains plant data from the plurality of power generation units via the respective communication networks, for the every plurality of power generation units calculates remaining life time of the machine and apparatus and the parts thereof in the concerned power generation unit by making use of the obtained plant data and prepares operation and maintenance plans for the respective power generation units by determining exchange time of the machine and apparatus and the parts thereof in the concerned power generation unit based on the calculated remaining life time thereof.

[0013]

According to the third aspect of the present invention, when preparing the operation and maintenance plans for the respective power generation units in the service center based on the power generation efficiency evaluated and calculated in real time, since the operation and maintenance planes are prepared based on the calculated remaining life time, an exchange timing of the machine and apparatus and the parts thereof can be determined with a high accuracy in comparison with the conventional power generation system in which exchange of the machine and apparatus and the parts thereof is performed with reference to an accumulated operation time thereof, as

a result, an abnormality occurrence due to a use of the machine and apparatus and the parts thereof exceeding their life time and generation of economical loss due to unplanned outage caused by an abnormality of the machine and apparatus and the parts thereof can be prevented, moreover, an exchange at every predetermined period of the machine and apparatus even having a remaining life time is unnecessitated, thereby, the maintenance cost can be reduced.

[0014]

A fourth aspect of the present invention is to provide an operation and maintenance planning aiding system for a power generation installation in which a plurality of power generation units, a power supply command center and a service center are arranged and connected via communication networks, the service center obtains plant data from the plurality of power generation units via the respective communication networks, for the every plurality of power generation units calculates remaining life time of the machine and apparatus and the parts thereof in the concerned power generation unit by making use of the obtained plant data, compares the calculated remaining life time with remaining life time of the machine and apparatus in the power generation unit determined in the other power generation unit, modifies the operation condition for the machine and apparatus and

the parts thereof so as to enhance economy and prolongs or shorten the remaining life time of the machine and apparatus and the parts thereof in the concerned power generation unit, thereby, prepares the operation and maintenance plans for the respective power generation units.

[0015]

According to the fourth aspect of the present invention, when preparing the operation and maintenance plans for the respective power generation units in the service center based on the power generation efficiency evaluated and calculated in real time, since the operation condition for the machine and apparatus in its own power generation unit is modified based on the remaining life time of the machine and apparatus and the parts thereof not only in its own power generation unit but also in other power generation unit, the operation and maintenance plans can be prepared so that the total cost necessary for the operation and maintenance for the respective power generation units is minimized, the cost merit obtained by the electric power generation by the electric power generation company can be increased in comparison with the convectional power generation system.

[0016]

[EMBODIMENTS OF THE INVENTION]

Hereinbelow, embodiments of the present invention will be explained with reference to the drawings.

[0017]

Fig. 1 is a block diagram showing a major constitution of an operation and maintenance planning aiding system for a power generation installation representing a first embodiment of the present invention.

[0018]

As shown in Fig. 1, the operation and maintenance planing aiding system for a power generation installation is constituted by a service center 1 which performs business of preparing an operation and maintenance plan, an electric power generation company 2 which owns two power generation plants 4 and 5, a power supply command center (central supply) 3 which commands outputs of power generation amount to the two power generation plants 4 and 5 in response to power demand amount, A power generation plant 4 including two power generation units 41 and 42, B power generation plant 5 including two power generation units 51 and 52 and a communication network 6 such as internet. In the present embodiment, the service center 1, the power supply command center 3, the power generation units 41 and 42, the power generation unit 51 and 52 are selectively connected via the communication network 6.

[0019]

The electric power generation company 2 requests the service center 1 the business of preparing an operation and maintenance plan for the power generation units 41 and 42 owned by the A power generation plant 4 and the power generation units 51 and 52 owned by the B power generation plant 5.

[0020]

Now, Fig. 2 is a block diagram of an exemplary constitution of the power generation unit 41 as shown in Fig. 1, and Fig. 3 is a block diagram of an exemplary constitution of the service center 1 as shown in Fig. 1.

[0021]

As shown in Fig. 2, the power generation unit 41 includes, at the side of a main body 411 of the power generation unit 41, a first sensor 412 for detecting a first process value, a second sensor 413 for detecting a second process value, a first control unit 414 for controlling a first portion in the main body 411, a second control unit 415 for controlling a second portion in the main body 411 and a process computer 416 for converting the first and second process values into transmission signals, and other than the above is provided with a process value transmission unit 417 and a fire wall 418 for performing communication. In a conventional power generation unit a process

computer has a function of computing processing values detected by the first and second sensors and all of the process values necessary for operating the power generation unit are stored in the data base. The process value transmission unit 417 obtains process values from the data base in the process computer 416, and transmits the same to the communication network 6 via the fire wall 418. At the moment of transmitting the process values, transmission time information and ID for specifying the power generation unit are transmitted altogether. Further, in the present embodiment, since an internet is used as the communication network 6, a fire wall 418 is provided in order to prevent an unauthorized access to the power generation unit 41 from outside, however, if an exclusive line is used in the communication network 6, the fire wall 418 can be omitted.

[0022]

Further, as shown in Fig. 3, the service center 1 is constituted by a fire wall 11, a process value receiving unit 12, a process value data base 13, a machine and apparatus model data base 14, a material information data base 15, a failure information data base 16, a manufacturer information data base 17, a design information data base 18, an efficiency diagnosis unit 19, a remaining life time diagnosis unit 20, a failure frequency evaluation unit 21, a

manufacturer priority evaluation unit 22, an electric power demand amount receiving unit 23, an operation plan information transmission unit 24, an operation plan evaluation unit 25, a periodic inspection information data base 26 and a machine and apparatus information data base 27, and these elements 11 through 27 are mutually connected as shown in Fig. 3.

[0023]

In the power generation unit 41, when the process value transmission unit 417 transmits process data which is transferred via the communication network 6 to the side of the service center 1, the service center 1 obtains via the fire wall 11 the process data, transfers the obtained process data from the process value receiving unit 12 to the process value data base 13 and stores the same therein. Further, other process data transferred from other power generation units 42, 51 and 52 are likely stored in the process value data base 13.

[0024]

Herein, Fig. 4 is a view for explaining storage contents in the process value data base as shown in Fig. 3 and shows a structure of the process data.

[0025]

As shown in Fig. 4, each of the process data is assigned of a process number representing ID for discriminating process value for every power

generation unit and is managed according to the process number. In the present embodiment, the service center 1 obtains process data in a predetermined cycle from the respective power generation units 41, 42, 51 and 52 and in the present first embodiment as will be seen from the contents with regard to time of the process data stored in the process value data base 13 the service center 1 obtains the process data in a cycle of 1 sec.

[0026]

The power supply command center 3 transmits a power demand amount required to be supplied by the electric power generation company 2 as a power demand information to the service center 1 via the communication network 6. Since the power demand information varies time to time depending on power demand, the information is transmitted in a predetermined cycle, for example, every 1 sec. to the service center 1. The service center 1 receives the power demand information via the fire wall 11 at the power demand amount receiving unit 23, and supplies the received power demand information to the operation plan evaluation unit 25. In this instance, the operation plan evaluation unit 25 distributes power generation amounts for the respective power generation units 41, 42, 51 and 52 so that the summed value of the power generation amounts of the respective power

generation unit 41, 42, 51 and 52 coincides with the required value, and supplies the distribution result to the operation plan information transmitting unit 24. The operation plan information transmitting unit 24 transmits the operation plan information, namely the power generation amount information distributed to the respective power generation units 41, 42, 51 and 52 to the power supply command center 3 via the communication network 6. The power supply command center 3 confirms the contents of the operation plan information sent from the service center 1 and outputs the command values of the power generation amount for the respective power generation units 41, 42, 51 and 52 according to the operation plan information.

[0027]

The explanation until now relates to the operation planning in response to power demand which varies time to time in the operation and maintenance planning aiding system for a power generation installation, however, other than the above, the present operation and maintenance planning aiding system for a power generation installation also prepares a long term operation plan. For example, the system prepares such maintenance plans in which, based on the plant data obtained through on-line, conditions of the machine and apparatus and the parts thereof in the power generation units are judged and such as

disassembling and inspection of the power generation units and exchanging of the parts thereof are performed according to the judgement result, and timing of the periodical inspection of the power generation units is adjusted.

[0028]

The above is an outline of the service which the service center 1 provides to the electric power generation company 2.

[0029]

Hereinbelow, details of processing steps performed by the service center 1 for preparing the operation and maintenance plan will be explained.

[0030]

The service center 1 uses power generation efficiency in the respective power generation units as one of parameters for preparing the operation plan. Hereinbelow, the processing for calculating the power generation efficiency will be explained.

[0031]

In the service center 1 as shown in Fig. 3, the evaluation of the power generation efficiency is performed at the efficiency diagnosis unit 19, which investigates models of the machine and apparatus constituting the power generation unit with reference to the design information data base 18.

[0032]

Fig. 5 is a view for explaining the storage contents of the design information data base 18 as shown in Fig. 3, and shows the structure of the design information data base.

[0033]

As shown in Fig. 5, the design information data are constituted by machines and apparatus and parts thereof constituting the respective power generation units and their supplying manufacturers and types for every machine, apparatus and part. For example, in the case of a first power generation unit (power generation unit 1) in power plant A, a product of A company of type GT001 is employed as a gas turbine, and as parts constituting the gas turbine, a combustor of B company of type CB003, a turbine of A company of type TB001 and a compressor of A company of type CP001 are employed.

[0034]

Further, the efficiency diagnosis unit 19 refers to a machine and apparatus model in the machine and apparatus model data base 14 in order to calculate the power generation efficiency.

[0035]

Fig. 6 is a view for explaining the storage contents in the machine and apparatus model data base 14 and shows the structure of the machine and apparatus data.

[0036]

As shown in Fig. 6, the machine and apparatus model data are constituted by parts or types and machine and apparatus model for every part and type, and the substance of the machine and apparatus model is a program operable on a computer. Further, each of the machine and apparatus model data is provided with a process number for the process value serving as an input and output of the program for every machine and apparatus model.

[0037]

The efficiency diagnosis unit 19 causes to operate the program according to the input and output specification stored in the machine and apparatus model data base 14.

[0038]

Now, processing steps which perform the efficiency diagnosis by making use of the machine and apparatus model will be explained.

[0039]

Fig. 7 is a view for explaining an outline constitution of a gas turbine. As shown in Fig. 7 a gas turbine is constituted by a compressor, a combustor and a turbine and between these elements air, combustion gas or fuel flows. For example, when the machine and apparatus model as shown in Fig. 7 is constituted by a combination of machine and apparatus

models of the compressor, combustor and turbine stored in the machine and apparatus model data base 14, a performance of the gas turbine as a whole can be calculated by calculating the performances of the respective machine and apparatus models. Namely, as shown in Fig. 7, when measured values such as fuel, shaft rpm, flow rate of intake air and temperature are set at the inputs of the machine and apparatus model, such as electrical power output and exhaust gas temperature to be output under the set conditions can be estimated. The calculation is performed under the precondition that the respective machine and apparatus models are operated normally. Therefore, when a deviation is caused between the estimated value determined by making use of machine and apparatus models and the actually measured value obtained from the plant data, it can be judged that the power generation unit generating such plant data is deviating from a normal condition.

[0040]

Fig. 8 is a characteristic diagram showing a secular change of an electric power output between estimated value using a machine and apparatus model and actually measured value obtained from a power generation unit, and the ordinate represents electrical power output and the abscissa represents time.

[0041]

As shown in Fig. 8, at the early stage the estimated value and the actually measured value substantially coincide, however, depending on time passage the deviation value between the estimated value and the actually measured value increases, which implies that deterioration of the gas turbine in the concerned power generation unit advances to decrease the performance thereof and no output according to one designed can be obtained anymore from the concerned power generation unit. In the present example, total performance of the gas turbine has been calculated, however, performance of the individual machines such as compressor, combustor and turbine can be calculated for the evaluation. In such instance, a part of which performance is decreasing can be specified which is effective for identifying the causes of failure.

[0042]

The efficiency diagnosis unit 19 converts the performance calculation result determined by means of the machine and apparatus models into power generation cost and compares the same with the power generation cost determined from the actual measurement value from the plant data.

[0043]

Fig. 9 is a characteristic diagram showing an analysis example of efficiency diagnosis performed in

an efficiency diagnosis unit 19; and the ordinate represents power generation cost and the abscissa represents output wherein evaluation of the estimated value by means of the machine and apparatus models and evaluation of the actually measured value obtained from the plant data are shown in comparison.

[0044]

In Fig. 9, the power generation cost is defined as a fuel cost necessary for outputting a unit power generation amount and the fuel cost is determined in a predetermined time internal (for example, every one hour). Further, in the evaluation based on the actually measured value in Fig. 9 the power generation cost is calculated by making use of the electrical power output and fuel flow rate stored in the process value data base 13 and the fuel cost obtained in advance, in that the power generation cost is calculated by multiplying the fuel cost to the fuel flow rate and by dividing the multiplied result with the electric power output. On the other hand, in the evaluation based on the estimated value by means of the machine and apparatus models in Fig. 9, the power generation cost is determined by making use of the fuel flow rate of actually measured value and the electrical power output of the estimated value by means of the machine and apparatus models. When plotting the respective power generation costs

determined according to the both methods for every load, and if the performances of the machines and apparatuses are those of as designed, the two plotted lines will coincide. The example as shown in Fig. 9 shows a case where the power generation cost increases due to performance deterioration of machines and apparatuses.

[0045]

Subsequently, the preparation of the operation and maintenance plan by making use of the power generation cost calculated in the efficiency diagnosis unit 19 is performed in the operation plan evaluation unit 25. Hereinbelow, the processing performed in the operation plan evaluation unit 25 will be explained.

[0046]

The operation plan evaluation unit 25 uses the power generation costs determined in on-line of the respective power generation units 41, 42, 51 and 52, and prepares a plan from economic point of view so as to positively operate a power generation unit or units having a lower power generation cost among the power generation units 41, 42, 51 and 52. For example, in the power generation unit 41 among the power generation units 41, 42, 51 and 52, if deterioration of, for example, the gas turbine among its constituting machines and apparatus advances and the efficiency thereof decreases, a deviation is caused

between the power generation cost based on the actually measured value determined from the process data in the power generation unit 41 and the power generation cost determined from the estimation value by means of the machine and apparatus models as explained above. In such instance, the operation plan evaluation unit 25 evaluates the economic loss due to the performance deterioration according to the following equation (1);

[0047]

[FORMULA 1]

$$L1=C\times A\times D1 \qquad \cdots(1)$$

wherein, L1: Economic loss due to performance deterioration (¥)

C: Power generation cost increase component due to the performance deterioration (¥/MWd)

A: Power generation amount (actual resultant value) per day (MWd/day)

D1: Remaining days until subsequent periodic inspection (days).

In the equation (1), the power generation amount A per day is determined by averaging the cumulative electric power output amount in respective operation days. When multiplying the power generation amount A per day with the remaining days D1 until the periodic inspection, an estimated possible power generation amount until the periodic inspection can be

calculated. Information with regard to a plan on the periodic inspection is stored in the periodic inspection information data base 26.

[0048]

Fig. 10 is a view for explaining storage contents of a periodic inspection data base 26, and shows a structure of the periodic inspection information data.

[0049]

As shown in Fig. 10, the periodic inspection information data are information representing periodic inspection time already performed in the past and periodic inspection time to be performed in the future, and based on the periodic inspection information data the remaining days until the subsequent periodical inspection is calculated. The economic loss (L1) due to performance deterioration can be calculated by multiplying the estimated power generation amount ($A \times D1$) until the subsequent periodic inspection by the power generation cost increase component (C).

[0050]

Subsequently, the operation plan evaluation unit 25 judges, in view of the power generation cost, whether operation of one power generation unit, for example, the power generation unit 41 has to be stopped and the machines and apparatuses and the parts thereof have to be exchanged or the operation thereof

has to be continued under the performance deteriorating condition. In this instance, the operation plan evaluation unit 25 calculates the cost in association with the change of the machines and apparatuses or the parts thereof with reference to the machine and apparatus information data base 27.

[0051]

Fig. 11 is a view for explaining storage contents of a machine and apparatus data base 27, and shows a structure of the machine and apparatus information data.

[0052]

As shown in Fig. 11, the machine and apparatus information data are constituted by manufacturer and type, purchased price and days necessary for installation work for every machine and apparatus and part thereof. In this instance, the cost in association with the exchange of the machines and apparatuses and the parts thereof is a sum of the current price of the machine and apparatus or the parts thereof in view of depreciation and the loss of electric power sales opportunity because of the power generation stopping due to the exchange work, and is expressed by the following equation (2);

[0053]

[FORMULA 2]

$$L2 = P \times (1-R) + A \times D2 \times E \quad \cdots (2)$$

wherein, L2: Economic loss (¥) in association with machine and apparatus / part exchange

P: Purchase price (¥) of exchanging machine and apparatus / parts

R: Thermal fatigue value (normalized value)(-)

A: Power generation amount per day (actual resultant value)(MWd/day)

D2: Days required for installation work (day)

E: Sales price of electric power (¥/MWd).

In the equation (2), with regard to the purchase price (P) of the machine and apparatus and parts, the information stored in the machine and apparatus information data base 27 is referred to. The depreciation is evaluated in view of the remaining life time and uses the thermal fatigue value (R) representing the remaining life time. The thermal fatigue value (R) is a normalized value, and under a brand-new condition when beginning the use, the value is 0 and the value increases depending on the use years and becomes to 1 when the exchange level has been reached. Namely, the thermal fatigue value (R) of 1 implies that the concerned machine and apparatus has been used up and no value remains there. A calculation method of the consumed life time value (R) will be explained later. Further, with regard to the loss of electric power sales opportunity, the power generation amount not generated because of exchange of

the machine and apparatus or the parts thereof can be calculated by multiplying the power generation amount (A) per day by the days (D2) required for installation work stored in the machine and apparatus information data base 27, and when the electric power sales price (E) is multiplied by the above calculated non-power generation amount, the economic loss in association with the exchange of the machine and apparatus or the parts thereof can be calculated.

[0054]

The operation plan evaluation unit 25 compares the economic loss (L1) due to the performance deterioration with the economic loss in association with the exchange of the machine and apparatus or the parts thereof. When the performance deterioration of the power generation unit advances and the economic loss (L1) exceeds the economic loss (L2), the operation plan evaluation unit 25 plans to stop the operation of the power generation unit and to exchange the machine and apparatus or the parts thereof, and further plans to compensate the power generation amount decreasing component due to the operation stopping of the power generation unit with a power generation amount increasing by other power generation unit or units.

[0055]

Further, the service center 1 uses the remaining

life time of the machine and apparatus or the parts thereof as one of parameters for preparing the operation plan. Hereinbelow, the processing of calculating the remaining life time will be explained.

[0056]

In the service center 1, the remaining life time diagnosis unit 20 performs evaluation of the remaining life time of machines and apparatuses or the parts thereof, and evaluates the remaining life time of the power generation unit based on the remaining life time evaluation data for the respective power generation units stored in the material information data base 15.

[0057]

Fig. 12 is a view for explaining storage contents of a material information data base 15, and shows the structure of the material information data, namely the remaining life time evaluation data.

[0058]

The thermal fatigue induced by thermal stress variation in association with the applied temperature are accumulated at the parts such as gas turbine which are subjected to a high temperature during the operation thereof. The thermal fatigue induces damages such as cracks if a predetermined critical value is exceeded and causes to a significant accident.

[0059]

As shown in Fig. 12, the remaining life time evaluation data are constituted by graphs representing accumulation of the thermal fatigue in the respective power generation unit (gas turbine). In the graph, the ordinate represents normalized thermal fatigue value, and the abscissa represents accumulation value of exhaust gas temperature variation rate for every 10 sec., and it is defined that when the thermal fatigue value reaches to 1, it is determined that the time for exchanging the part comes. Namely, the accumulation value of the exhaust gas temperature variation rate in the gas turbine is a value obtained in such a manner that after the absolute value difference between the current exhaust gas temperature value and that of before 10 sec. (representing variation rate in 10 sec.) is multiplied by a normalized constant and the multiplication results are added for every 10 sec., therefore, the thermal fatigue value simply increases depending on lapse of time.

[0060]

Fig. 13 is a graph obtained by plotting variation condition of thermal fatigue value with respect to time as determined according to the above processing, and shows an analysis example performed by the remaining life time diagnosis unit 19.

[0061]

The thermal fatigue value of a brand-new gas

turbine at the time of installation is 0 and the value gradually increases through repetition of such operations including temperature variation as starting up / stopping and load adjustment. In order to evaluate the remaining life time of a gas turbine, based on the thermal fatigue value until now, a possible thermal fatigue value thereafter is extrapolated and estimated according to the mathematical formula representing the thermal fatigue value, and the remaining life time is determined by the thermal fatigue value until the estimated result reaches to the thermal fatigue value of 1 representing the exchange level.

[0062]

In the service center 1, the operation plan evaluation unit 25 obtains the remaining life time data evaluated by the remaining life time diagnosis unit 20 and prepares the operation plan by making use of the obtained remaining life time.

[0063]

Fig. 14 is a flow chart showing a processing flow when an operation plan evaluation unit 25 prepares an operation plan for a certain power generation unit by making use of remaining life time data.

[0064]

The flow chart will be explained with reference to Fig. 14, at first in step S1 the operation plan

evaluation unit 25 obtains the remaining life time data evaluated by the remaining life time diagnosis unit 20 and calculates the remaining life time days.

[0065]

Subsequently, in step S2, the operation plan evaluation unit 25 determines the days until the subsequent periodic inspection for the concerned power generation unit with reference to the periodic inspection information data base 26 and judges whether the calculated remaining life time days are larger or shorter than the determined days until the subsequent periodic inspection. Then, if it is judged that the remaining life time days are longer than the days until the subsequent periodic inspection (Y), the process moves to the next step S3, on the other hand, if it is judged that the remaining life time days are shorter than the days until the subsequent periodic inspection (N), the process moves to the next step S4.

[0066]

Subsequently, in step S3, the operation plan evaluation unit 25 prepares an operation plan for the concerned power generation unit to perform a usual operation and ends the series of processings in the flow chart.

[0067]

Further, in step S4, the operation plan evaluation unit 25 reduces the maximum power

generation amount in the concerned power generation unit by 25% and sets the same at 75% of the current power generation mount, and further reduces the load adjustment amount which varies depending on the power demand by 25% and sets the same at 75% of the current load adjustment amount, and prepares an operation plan which intends to prolong the remaining life time of the concerned power generation unit.

[0068]

In the subsequent step S5, the operation plan evaluation unit 25 judges whether or not the maximum power generation amount in the concerned power generation unit has been reduced by 100%. Then, if it is judged that the maximum power generation amount has been reduced by 100% (Y), the process moves to the subsequent step S6, on the other hand, it is judged that the maximum power generation amount has not yet been reduced by 100% (N), the process moves to another step S7.

[0069]

In step S6, the operation plan evaluation unit 25 repeats the process in step S4 four times which will be explained later, even through repeating the processings if the end of the life time is reached, the operation plan evaluation unit 25 prepares an operation plan to stop the operation of the concerned power generation unit and ends the series of

processings in the flow chart.

[0070]

Further, in step S7, the operation plan evaluation unit 25 prepares an operation plan which permits to continue the operation of the concerned power generation unit for a week. Then, after a week when completing the operation plan, the process returns to step S1 and the operation plan evaluation unit 25 again causes to repeat steps following step S1.

[0071]

In parallel with the above operation plan, the operation plan evaluation unit 25 prepares an operation plan in which another power generation unit having a higher power generation efficiency is positively selected for operation based on the power generation efficiency of the respective power generation units calculated in on-line. For example, as shown in Fig. 9, if the performance of a power generation unit is reduced, the power generation efficiency thereof reduces, therefore, a probability of continuing operation of the power generation unit is reduced. Then, the operation plan evaluation unit 25 prepares a maintenance plan for performing exchange of the machine and apparatus or the parts thereof for the power generation unit of which operation is judged to be stopped according to the remaining life time

diagnosis result for the respective power generation units.

[0072]

The above explanation shows an example in which, when preparing an operation and maintenance plan for power generation units by making use of the remaining life time data, deterioration of the machine and apparatus or the parts thereof advances more than that estimated and the exchange timing is hastened. When preparing a usual operation and maintenance plan for power generation units it is planned based on the remaining life time data to exchange the machine and apparatus or the parts thereof at the time of the periodic inspection, however, if the end of the remaining life time comes earlier than that estimated because of changes in operation circumstance it is possible to prepare an operation plan which prevents the machine and apparatus or the parts thereof exceeding their life time from using. Therefore, the operation and maintenance plan aiding system for a power generation installation according to the present embodiment can avoid unpredictable circumstances which causes unplanned outage of the power generation unit due to an abnormality caused by the use of the machine and apparatus or the parts thereof exceeding their life times, and can also avoid the economic loss caused by the unplanned outage of the power generation

unit.

[0073]

Contrary to the above example, an example can be prepared in which, based on remaining life time diagnosis result evaluated in real time, the exchange timing of the machine and apparatus or the parts thereof can be prolonged. For example, since a gas turbine is subjected to a high temperature and the deterioration thereof advances rapidly, an exchange standard time (for example, an accumulated operation time of 50,000 hours) is set in advance, and exchange of the machine and apparatus or the parts thereof is performed during the periodic inspection so as not to exceed the standard time. In such instance, if the remaining life time of the machine and apparatus or the parts thereof remains long, it is not necessarily required to exchange the machine and apparatus or the parts thereof when the standard time is reached, and the exchange timing can be extended. In such instance, in comparison with the exchange of the machine and apparatus or the parts thereof with reference to the standard time, the maintenance cost can be reduced.

[0074]

Further, the service center 1 uses failure frequency of the machine and apparatus as one of parameters for preparing an operation plan.

Hereinbelow, the processing for calculating the failure frequency of the machine and apparatus will be explained.

[0075]

In the service center 1, a portion for evaluating failure frequency of the machine and apparatus is a failure frequency evaluation unit 21. The failure frequency evaluation unit 21 evaluates the failure frequency of the machine and apparatus based on failure information data stored in failure information data base 16.

[0076]

Fig. 15 is a view for explaining storage contents of a failure information data base 16, and shows a structure of the failure information data.

[0077]

As shown in Fig. 15, the failure information data show failure histories caused in the respective power generation units, for example, at the first power generation unit in power generation plant A on September 10, 2000 a packing deterioration in an A company manufactured valve of type VL 0010 was caused and the same was repaired and further it is indicated that the same valve was exchanged on March 10, 1992. According to the contents of the failure information data it is understood that the valve has failed after about eight year and six month use. A similar

information is indicated with regard to the pump in the second power generation unit in the power generation plant B.

[0078]

The failure frequency evaluation unit 21 evaluates with how much probability (once in how many years) a failure of the respective machines and apparatuses or the parts thereof is caused by making use of the data stored in the failure information data base 16 and supplies the evaluation result to the operation plan evaluation unit 25.

[0079]

The operation plan evaluation unit 25 evaluates whether the machine and apparatus or the parts thereof in the respective power generation units can be used without failure upto which periodic inspection timing in future by making use of the evaluation result supplied from the failure frequency evaluation unit 21 and the reference result of the periodic information data base 26. Thereafter, when it is estimated according to the failure probability of the machines and apparatuses or the parts thereof that there are machine and apparatus or the parts thereof which only endures upto the timing of the subsequent periodic inspection, exchange of the machine and apparatus or the parts thereof is planned.

[0080]

Further, the service center 1 uses a priority of manufacturers as one of parameters for preparing the operation plan. Hereinbelow, the processing for calculating the priority of manufacturers will be explained.

[0081]

In the service center 1, the manufacturer priority evaluation unit 22 evaluates priority of manufacturers based on the respective manufacturer information stored in the manufacturer information data base 17.

[0082]

Fig. 16 is a view for explaining storage contents of a manufacturer information data base 17, and shows a structure of the manufacturer information data.

[0083]

As shown in Fig. 16, in the manufacturer information data, with respect to the respective machines and apparatuses or parts thereof the reliability and maintenance capacity for every manufacturer are evaluated by making use of A, B and C as evaluation references. In this instance, point 10 is assigned for A, point 5 for B and point 0 for C, and by determining the total points the priority of the manufacturers are determined according to the total points.

[0084]

When the operation plan evaluation unit 25 selects a power generation unit for operation and if the manufacturer priority of the machine and apparatus or the parts thereof used in the power generation unit is high, the operation plan evaluation unit 25 prepares a plan which positively selects the concerned power generation unit for the operation.

[0085]

As has been explained hitherto, the operation and maintenance plan aiding system for a power generation installation according to the present embodiment uses the performance diagnosis result, the remaining life time diagnosis result, the failure frequency and the priority of manufacturers when preparing an operation and maintenance plan for the respective power generation units.

[0086]

Fig. 17 is a block diagram showing a major constitution of an operation and maintenance planning aiding system for a power generation installation representing a second embodiment of the present invention.

[0087]

In the embodiment as shown in Fig. 17, the power generation unit 41 includes two shafts 61 and 62, the power generation unit 42 includes two shafts 71 and 72, the power generation unit 51 includes shafts 81

and 82 and the power generation unit 52 includes shafts 91 and 92, and wherein the power generation amount in the respective power generation units 41, 42, 51 and 52 is adjusted for every shafts 61, 62, 71, 72, 81, 82, 91 and 92. Further, in Fig. 17 the same or equivalent elements as those in Fig. 1 are denoted by the same reference numerals.

[0088]

In Fig. 17, the shafts 61, 62, 71, 72, 81, 82, 91 and 92 designate rotating shaft for transferring motive power of turbines to generators and each of the power generation units 41, 42, 51 and 52 includes a plurality of generators and each of the plurality of generators is coupled with one or a plurality of turbines. For such power generation units 41, 42, 51 and 52, when the power generation amount is set for every shafts 61, 62, 71, 72, 81, 82, 91 and 92, namely for every generator, an extremely fine operation and maintenance plan can be prepared. For example, such a plan can be prepared that one of the plurality of shafts 61, 62, 71, 72, 81, 82, 91 and 92 constituting the power generation units 41, 42, 51 and 52 is stopped for operation and the operation of the other shafts is continued.

[0089]

In this instance, since other operation of the operation and maintenance plan aiding system for a

power generation installation of the second embodiment as shown in Fig. 17 is substantially the same as that of the operation and maintenance plan aiding system for a power generation installation of the first embodiment as has already been explained above, the explanation of the operation of the second embodiment is omitted.

[0090]

Fig. 18 is a block diagram showing a major constitution of an operation and maintenance planning aiding system for a power generation installation representing a third embodiment of the present invention.

[0091]

In the embodiment shown in Fig. 18, one power supply command center is provided for each of the power generation plants 4 and 5, in that a power supply command center 3 is provided for the power generation plant 4 and a power supply command center 7 is provided for the power generation plant 5. Further, in Fig. 18 the same or equivalent elements as those in Fig. 1 are denoted by the same reference numerals.

[0092]

In the third embodiment, the service center 1 separately determines the power generation amount of the power generation units 41 and 42 which are under

control of the power supply command center 3 and the power generation amount of the power generation units 51 and 52 which are under control of the power supply command center 7 in response to the power generation amount required by the respective power supply command centers 3 and 7 and being transmitted via the communication network 6, and transfers the determined result to the respective power supply command centers 3 and 7 via the communication network 6.

[0093]

In this instance, since other operation of the operation and maintenance plan aiding system for a power generation installation of the third embodiment as shown in Fig. 18 is substantially the same as that of the operation and maintenance plan aiding system for a power generation installation of the first embodiment as has already been explained above, the explanation of the third embodiment is omitted.

[0094]

Fig. 19 is a block diagram showing a major constitution of an operation and maintenance planning aiding system for a power generation installation representing a fourth embodiment of the present invention.

[0095]

In the embodiment as shown in Fig. 19 no power supply command center is provided, instead thereof

operation planning sections 43 and 53 are provided for the respective power generation plants 4 and 5. A power supply command center has a role to adjust power generation amount of power generation units under its control in response to power demand which varies moment by moment. In constant, in the present embodiment, the operation planning sections 43 and 53 function to operate the respective power generation units 41, 42, 51 and 52 according to a power generation plan determined in advance.

[0096]

In this instance, since other operation of the operation and maintenance plan aiding system for a power generation installation of the fourth embodiment as shown in Fig. 19 is substantially the same as that of the operation and maintenance plan aiding system for a power generation installation of the first embodiment as has already been explained above, the explanation of the operation of the fourth embodiment is omitted.

[0097]

[ADVANTAGES OF THE INVENTION]

According to the first aspect of the present invention the following advantage is obtained, in that, since the operation and maintenance plans for the respective power generation units are prepared in the service center based on the power generation

efficiency evaluated and calculated in real time, a secular change and a performance degradation due to failure occurrence for the respective power generation units can be taken into account, thereby, the operation cost thereof can be reduced in comparison with the conventional power generation system in which the operation and maintenance plans for the respective power generation units are prepared by making use of the plant data.

[0098]

According to the second aspect of the present invention the following advantage is obtained, in that, when preparing the operation and maintenance plans for the respective power generation units in the service center based on the power generation efficiency evaluated and calculated in real time, since the cost of economical loss due to the performance degradation is calculated from the deviation value between the process value estimated using the machine and apparatus model and the measured value, the cost of economical loss is compared with the cost relating to the exchange of the machine and apparatus and the parts thereof and the operation and maintenance plan of the respective power generation units are prepared by making use of the comparison result, the total cost for the operation and maintenance can be reduced.

[0099]

According to the third aspect of the present invention the following advantage is obtained, in that, when preparing the operation and maintenance plans for the respective power generation units in the service center based on the power generation efficiency evaluated and calculated in real time, since the operation and maintenance plans are prepared based on the calculated remaining life time, an exchange timing of the machine and apparatus and the parts thereof can be determined with a high accuracy in comparison with the conventional power generation system in which exchange of the machine and apparatus and the parts thereof is performed with reference to an accumulated operation time thereof, as a result, an abnormality occurrence due to a use of the machine and apparatus and the parts thereof exceeding their life time and generation of economical loss due to unplanned outage caused by an abnormality of the machine and apparatus and the parts thereof can be prevented, moreover, an exchange in every predetermined period of the machine and apparatus even having a remaining life time is unnecessitated, thereby, the maintenance cost can be reduced.

[0100]

According to the fourth aspect of the present invention the following advantage is obtained, in

that, when preparing the operation and maintenance plans for the respective power generation units in the service center based on the power generation efficiency evaluated and calculated in real time, since the operation condition for the machine and apparatus in its own power generation unit is modified based on the remaining life time of the machine and apparatus and the parts thereof not only in its own power generation unit but also in other power generation unit, the operation and maintenance plans can be prepared so that the total cost necessary for the operation and maintenance for the respective power generation units is minimized, the cost merit obtained by the electric power generation by the electric power generation company can be increased in comparison with the convectional power generation system.

[BRIEF DESCRIPTION OF THE DRAWINGS]

Fig. 1 is a block diagram showing a major constitution of an operation and maintenance planning aiding system for a power generation installation representing a first embodiment of the present invention;

Fig. 2 a block diagram of an exemplary constitution of a power generation unit as shown in Fig. 1;

Fig. 3 is a block diagram of an exemplary

constitution of a service center as shown in Fig. 1;

Fig. 4 is a view for explaining storage contents of a process value data base as shown in Fig. 3 and shows a structure of the process data;

Fig. 5 is a view for explaining storage contents of a design information data base as shown in Fig. 3 and shows a structure of the design information data;

Fig. 6 is a view for explaining storage contents of a machine and apparatus model data base and shows a structure of the machine and apparatus model data;

Fig. 7 is a view for explaining a schematic constitution of a gas turbine;

Fig. 8 is a characteristic diagram showing a secular change of an electric power output between estimated value using a machine and apparatus model and actually measured value obtained from a power generation unit;

Fig. 9 is a characteristic diagram showing an analysis example of efficiency diagnosis performed in an efficiency diagnosis unit;

Fig. 10 is a view for explaining storage contents of a periodic inspection data base, and shows a structure of the periodic inspection information data;

Fig. 11 is a view for explaining storage contents of a machine and a apparatus data base, and shows a structure of the machine and apparatus information data;

Fig. 12 is a view for explaining storage contents of a material information data base;

Fig. 13 is a graph obtained by plotting variation condition of thermal fatigue value with respect to time;

Fig. 14 is a flow chart showing a processing flow when an operation plan evaluation unit prepares an operation plan by making use of remaining life time data;

Fig. 15 is a view for explaining storage contents of a failure information data base, and shows a structure of the failure information data;

Fig. 16 is a view for explaining storage contents of a manufacturer information data base, and shows a structure of the manufacturer information data;

Fig. 17 is a block diagram showing a major constitution of an operation and maintenance planning aiding system for a power generation installation representing a second embodiment of the present invention;

Fig. 18 is a block diagram showing a major constitution of an operation and maintenance planning aiding system for a power generation installation representing a third embodiment of the present invention; and

Fig. 19 is a block diagram showing a major constitution of an operation and maintenance planning

aiding system for a power generation installation representing a fourth embodiment of the present invention.

[EXPLANATION OF REFERENCE NUMERALS]

1: Service center

2: Electric power generation company

3, 7: Power supply command center (Central supply)

4, 5: Power plant

6: Telecommunication network (Internet)

11, 418: Fire wall

12: Process value receiving unit

13: Process value data base

14: Machine and apparatus model data base

15: Material information data base

16: Failure information data base

17: Manufacturer information data base

18: Design information data base

19: Efficiency diagnosis unit

20: Remaining life time diagnosis unit

21: Failure frequency evaluation unit

22: Manufacturer priority evaluation unit

23: Electric power demand amount receiving unit

24: Operation plan information transmission unit

25: Operation plan evaluation unit

26: Periodic inspection information data base

27: Machine and apparatus information data base

41, 42, 51, 52: Electric power generation unit

43: Operation planning section

411: Main body

412: First sensor

413: Second sensor

414: First control unit

415: Second control unit

416: Process computer

417: Process value transmission unit.

[NAME OF THE DOCUMENT] Document of Abstract

[ABSTRACT]

[PROBLEMS] To provide an operation and maintenance planning aiding system for a power generation installation which prepares an operation plan for a plurality of power generation units by making use of actual plant data and based on a total judgement including a variety of circumstances of the machine and apparatus or the parts thereof in the power generation units.

[COUNTER MEASURE] In the system the plurality of power generation units 41, 42, 51 and 52, a power supply command center 3 and a service center 1 are arranged and connected via a communication network 6, the service center 1 obtains the plant data via the communication network 6 from the plurality of power generation units 41, 42, 51 and 52, calculates in real time a power generation efficiency of a concerned power generation unit for every plurality of power generation units 41, 42 51 and 52 by making use of the obtained plant data and design data of the concerned power generation unit and prepares an operation and maintenance plan for each of the power generation units based on the calculated power generation efficiency.

[DRAWING TO BE SELECTED] Fig. 1.

FIG. 1

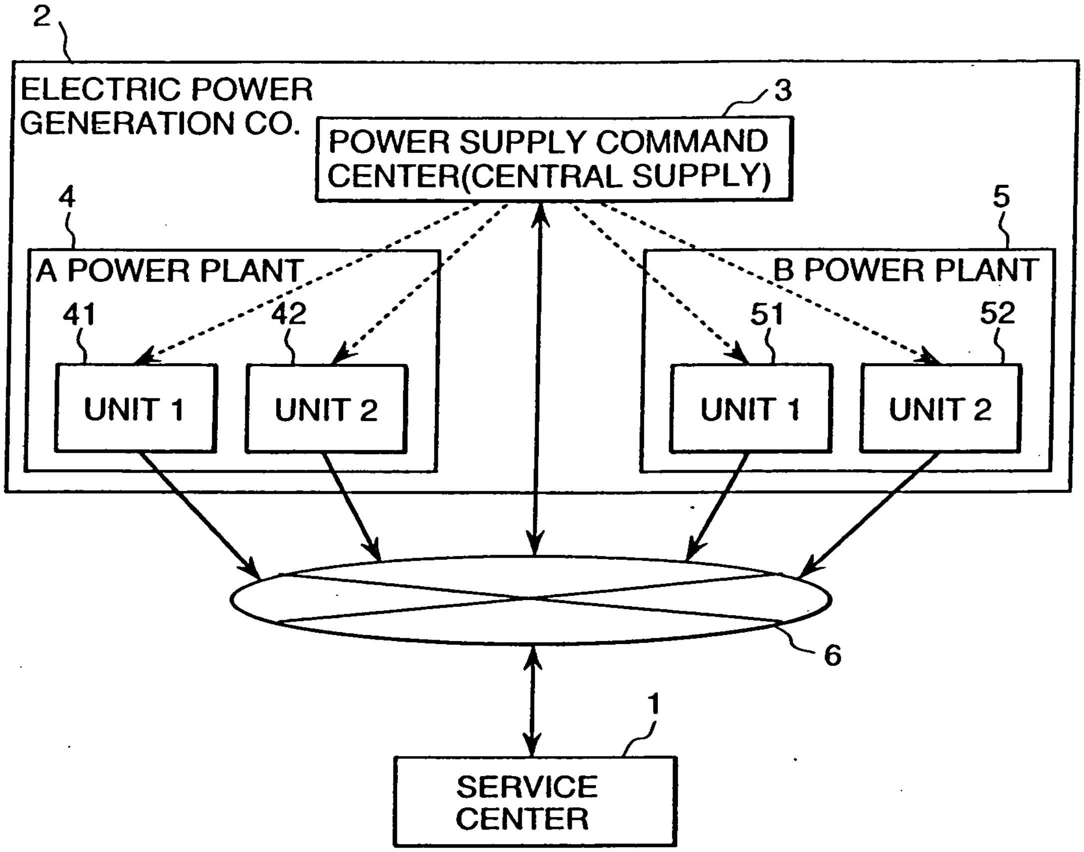

2
ELECTRIC POWER GENERATION CO.
3
POWER SUPPLY COMMAND CENTER(CENTRAL SUPPLY)
4
A POWER PLANT
41
42
UNIT 1
UNIT 2
5
B POWER PLANT
51
52
UNIT 1
UNIT 2
6
1
SERVICE CENTER

FIG. 2

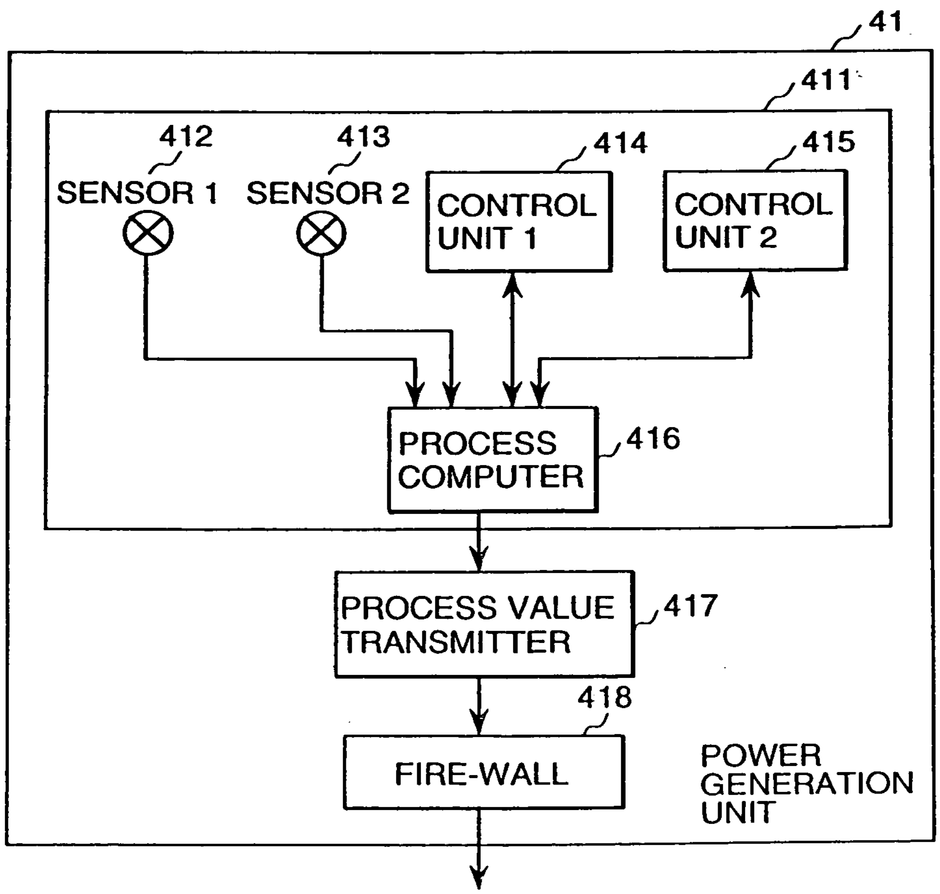

41
411
412
413
SENSOR 1
SENSOR 2
414
CONTROL UNIT 1
415
CONTROL UNIT 2
PROCESS COMPUTER
416
PROCESS VALUE TRANSMITTER
417
418
FIRE-WALL
POWER GENERATION UNIT

FIG. 3

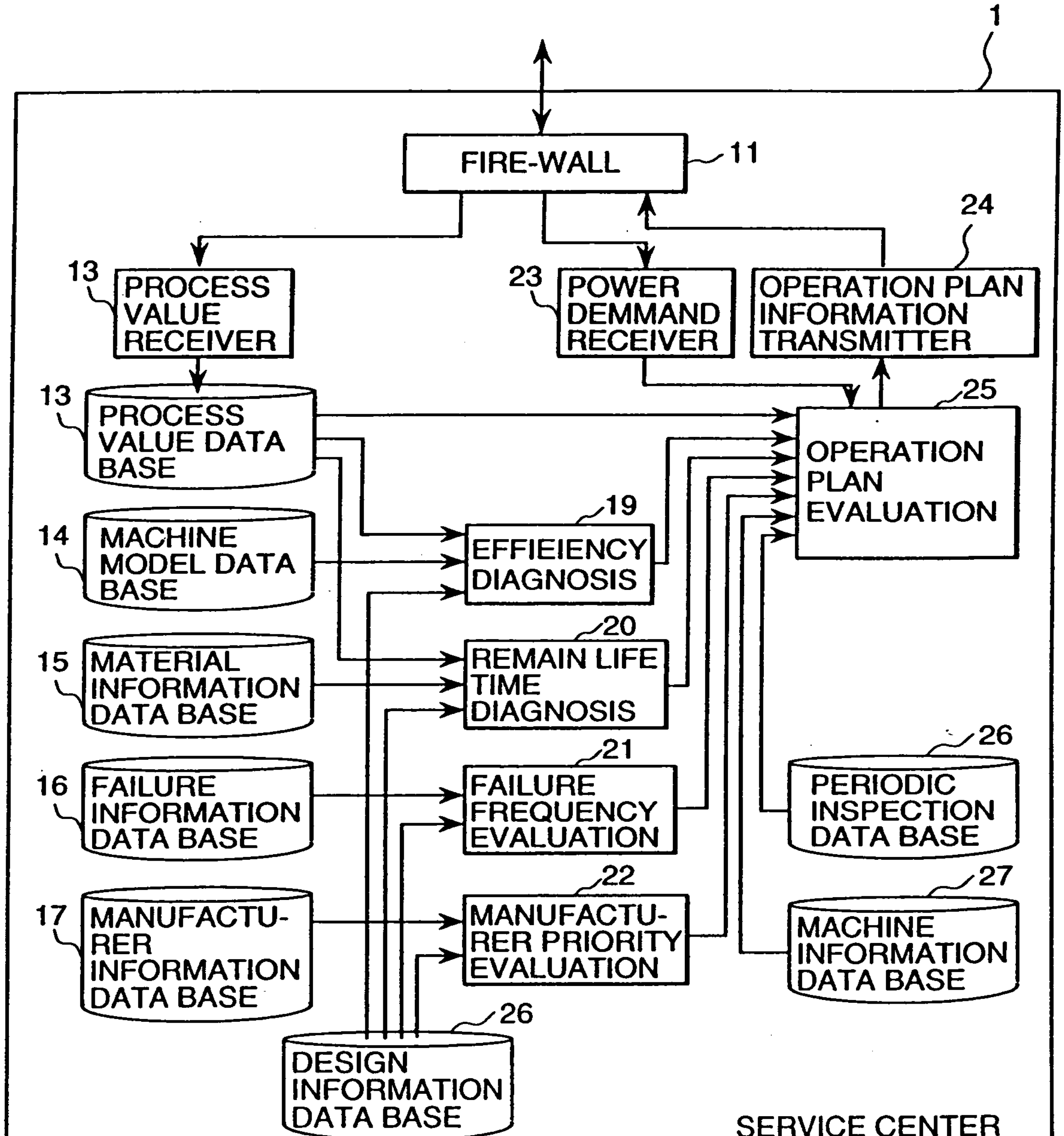

1
FIRE-WALL
11
13
PROCESS VALUE RECEIVER
23
POWER DEMMAND RECEIVER
24
OPERATION PLAN INFORMATION TRANSMITTER
13
PROCESS VALUE DATA BASE
25
OPERATION PLAN EVALUATION
14
MACHINE MODEL DATA BASE
19
EFFIEIENCY DIAGNOSIS
15
MATERIAL INFORMATION DATA BASE
20
REMAIN LIFE TIME DIAGNOSIS
16
FAILURE INFORMATION DATA BASE
21
FAILURE FREQUENCY EVALUATION
26
PERIODIC INSPECTION DATA BASE
17
MANUFACTU-RER INFORMATION DATA BASE
22
MANUFACTU-RER PRIORITY EVALUATION
27
MACHINE INFORMATION DATA BASE
26
DESIGN INFORMATION DATA BASE
SERVICE CENTER

FIG. 4

PROCESS VALUE DATA BASE

POWER PLANT	UNIT	PROCESS No.	PROCESS VALUE			
		TIME	12:00:20	12:00:19	12:00:18	...
POWER PLANT A	UNIT 1	PID001	100.0	99.0	99.5	
		PID002	120.0	119.0	118.0	
		PID003	100.0	100.0	100.0	
		⋮				
	UNIT 2					

FIG. 5

DESIGN INFORMATION DATA BASE

POWER PLANT	UNIT	MACHINE (MANUFATURER/TYPE)	PARTS (MANUFACTURER/TYPE)
POWER PLANT A	UNIT 1	GAS TURBINE(A Co./GT001)	COMBUSTOR(B Co./CB003)
			TURBINE(A Co./TB001)
			COMPRESSOR(A Co./CP001)
		GENERATOR(B Co./GN005)	
			⋮

FIG. 6

PART	MANUFATURER/ TYPE	MACHINE MODEL	INPUT OUTPUT SPECIFICATION
COMPRESSOR	A Co./CP001	MODEL CP001	INPUT:PID010,PID015, · · OUTPUT:PID030,PID035, · ·
	B Co./CP001	MODEL CP003	
	⋮		
TURBINE	A Co./ TB001		

FIG. 7

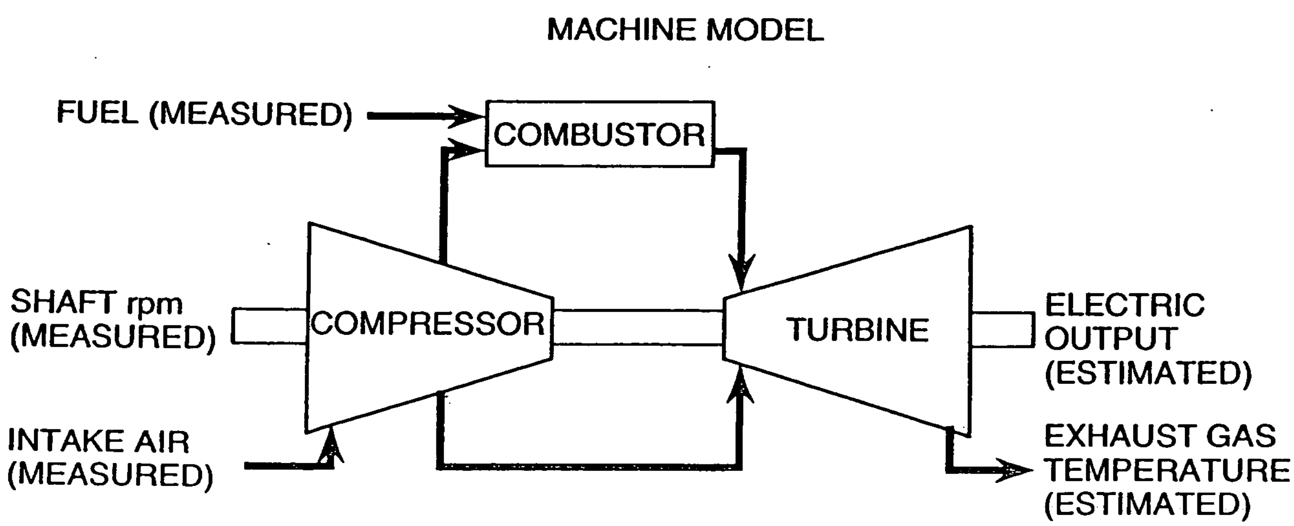


FIG. 8

PERFORMANCE DETERIORATION JUDGEMENT MAKING USE OF MACHINE MODEL

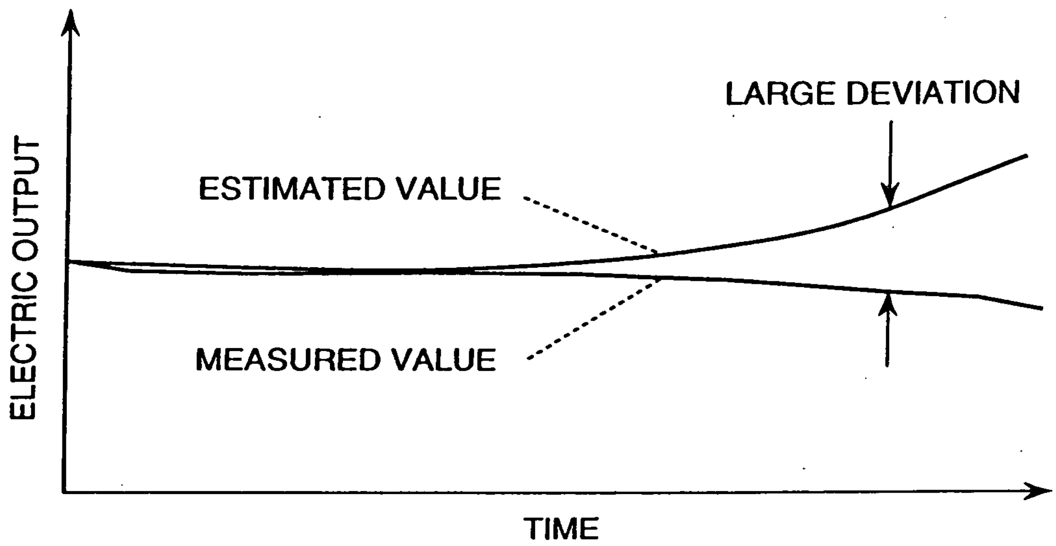


FIG. 9

ANALYSIS EXAMPLE OF EFFICIENCY DIAGNOSIS

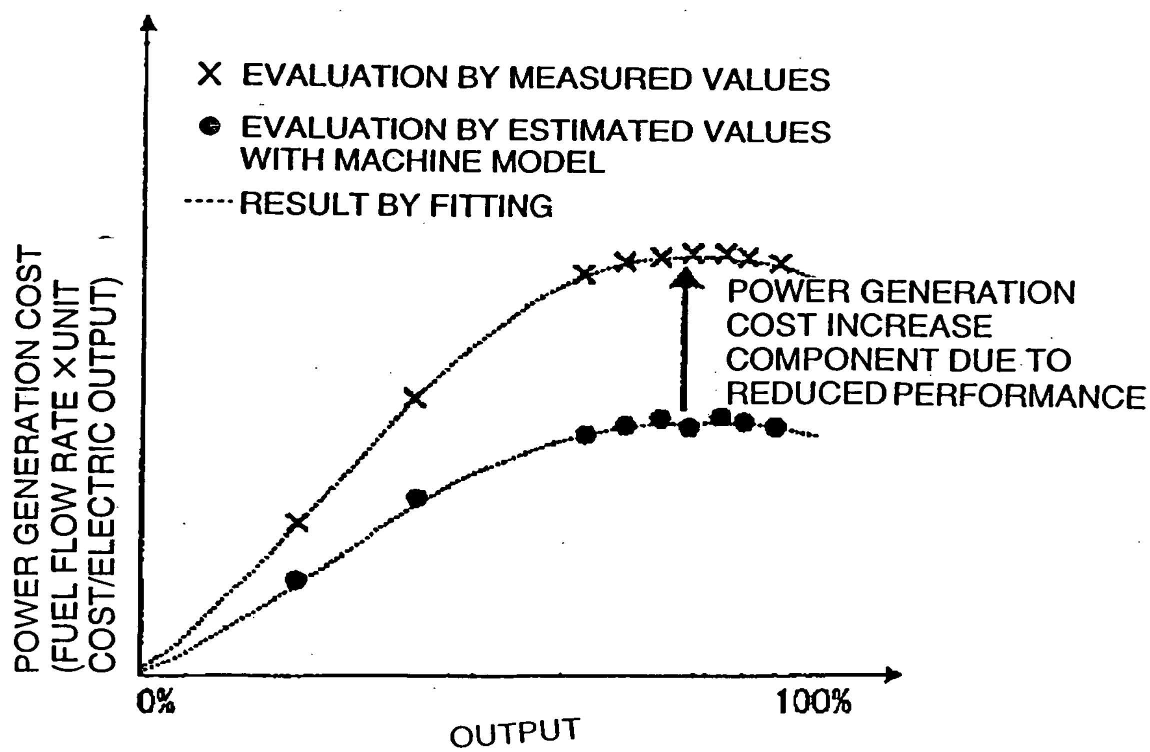


FIG. 10

PERIODIC INSPECTION INFORMATION DATA BASE

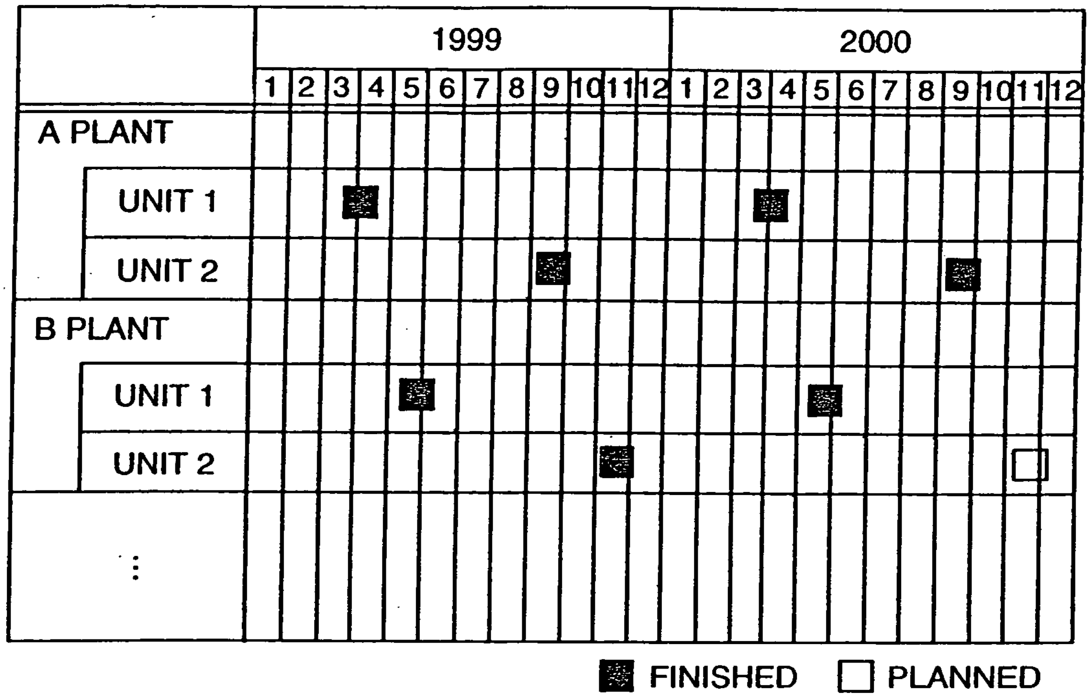


FIG. 11

MACHINE INFORMATION DATA BASE

MACHINE/ PARTS	MANUFACTURER/ TYPE	PURCHASED PRICE	DAYS FOR INSTALLATION
GAS TURBINE	A Co./GT001	20000M	10 DAY
	B Co./GT003	16000M	14 DAY
	C Co./GT001	24000M	8 DAY
	⋮	⋮	⋮
⋮	⋮	⋮	⋮

FIG. 12

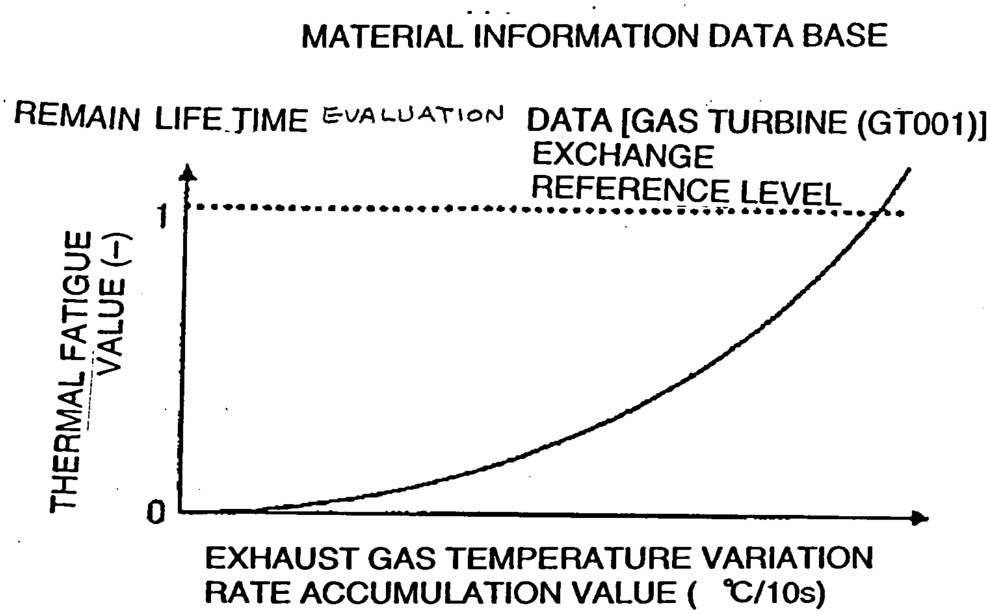

MATERIAL INFORMATION DATA BASE
REMAIN LIFE TIME EVALUATION DATA [GAS TURBINE (GT001)]
EXCHANGE
REFERENCE LEVEL
1
0
THERMAL FATIGUE VALUE (–)
EXHAUST GAS TEMPERATURE VARIATION
RATE ACCUMULATION VALUE (℃/10s)

FIG. 13

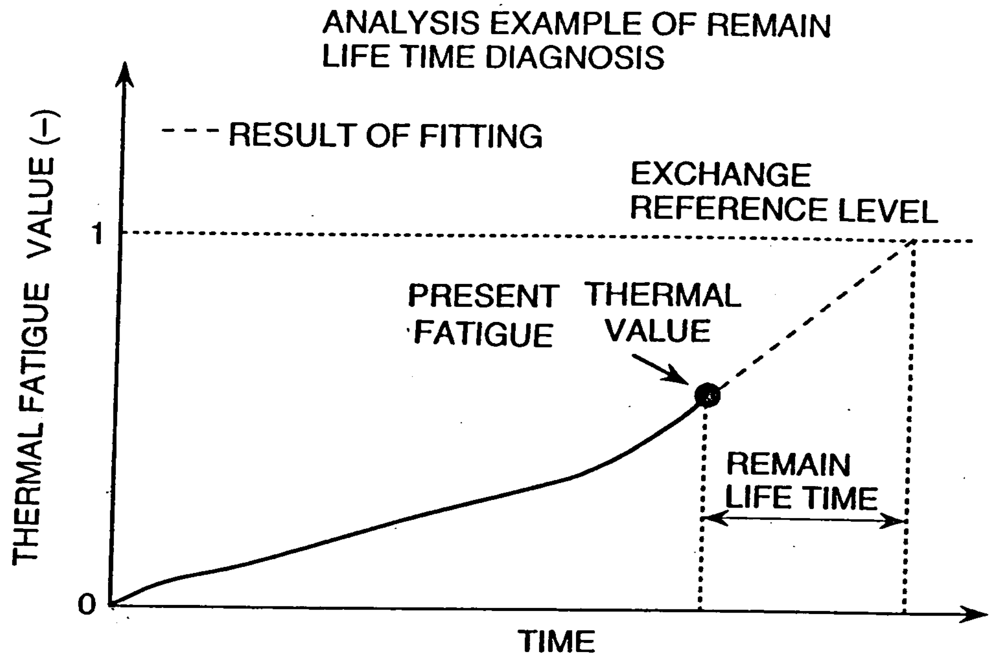


FIG. 15

FAILURE INFORMATION DATA BASE

DATE OF FAILURE OCCURRED	PLANT	UNIT	PARTS (MANUFACTURER/ TYPE)	DATE OF PREVIOUS REPAIR, EXCHANGE	CAUSE OF FAILURE
2000.9.10	PLANT A	UNIT 1	VALVE (A Co./VL0010)	1992.3.20	PACKING DETERIO-RATION
1998.6.5	PLANT B	UNIT 2	PUMP (B Co./PU032)	1990.4.1	COUPLING BREAKAGE
⋮	⋮	⋮	⋮	⋮	⋮

FIG. 16

MANUFACTURER INFORMATION DATA BASE

MANUFACTURER	RELIABILITY	MAINTENANCE CAPACITY
A Co.	A	A
B Co.	A	B
C Co.	B	B
	⋮	⋮

FIG. 14

FLOW OF OPERATION AND MAINTENANCE PLANNING MAKING USE OF REMAIN LIFE TIME DIAGNOSIS RESULT

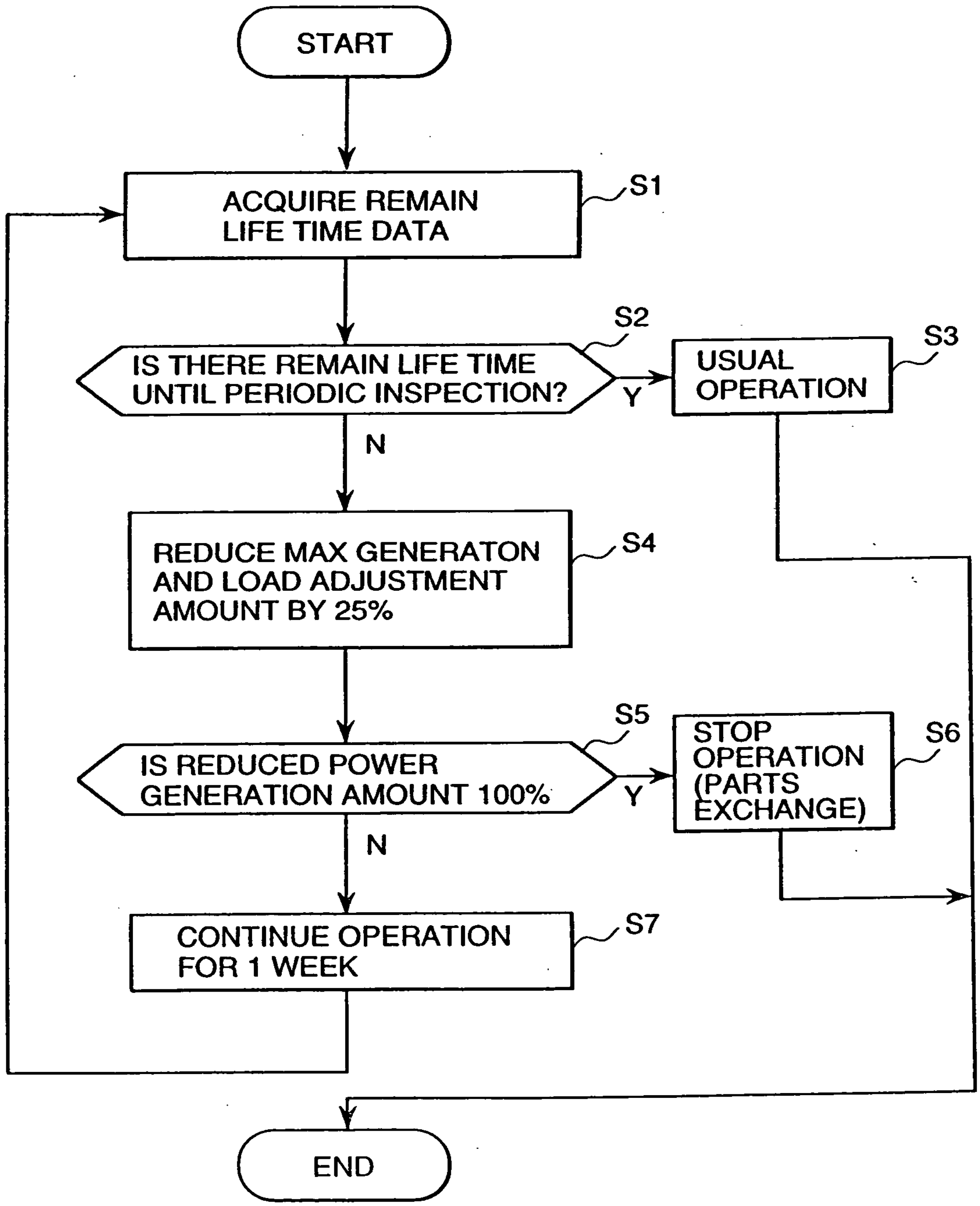


FIG. 17

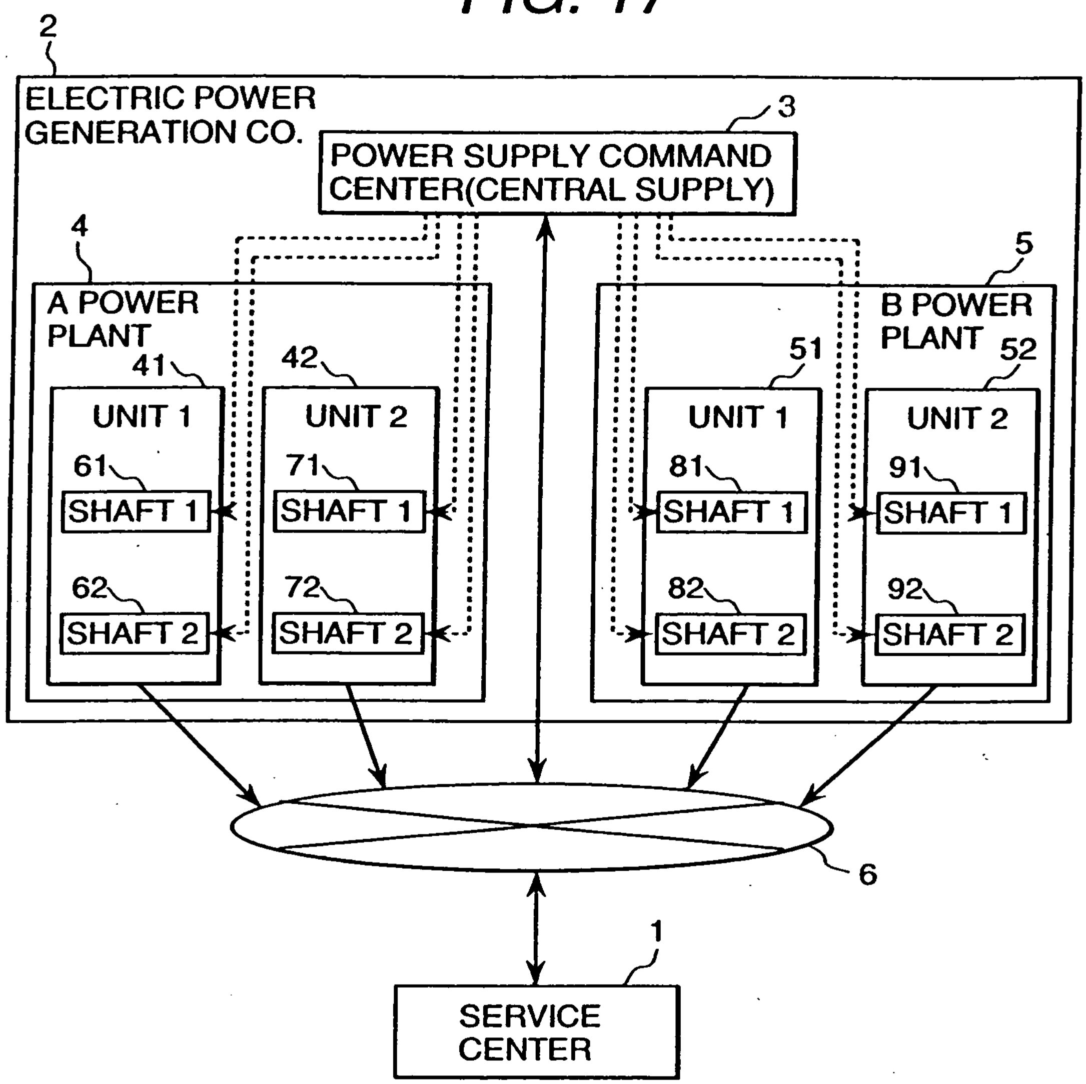

2
ELECTRIC POWER
GENERATION CO.
3
POWER SUPPLY COMMAND
CENTER(CENTRAL SUPPLY)
4
A POWER
PLANT
41
UNIT 1
61
SHAFT 1
62
SHAFT 2
42
UNIT 2
71
SHAFT 1
72
SHAFT 2
5
B POWER
PLANT
51
UNIT 1
81
SHAFT 1
82
SHAFT 2
52
UNIT 2
91
SHAFT 1
92
SHAFT 2
6
1
SERVICE
CENTER

FIG. 18

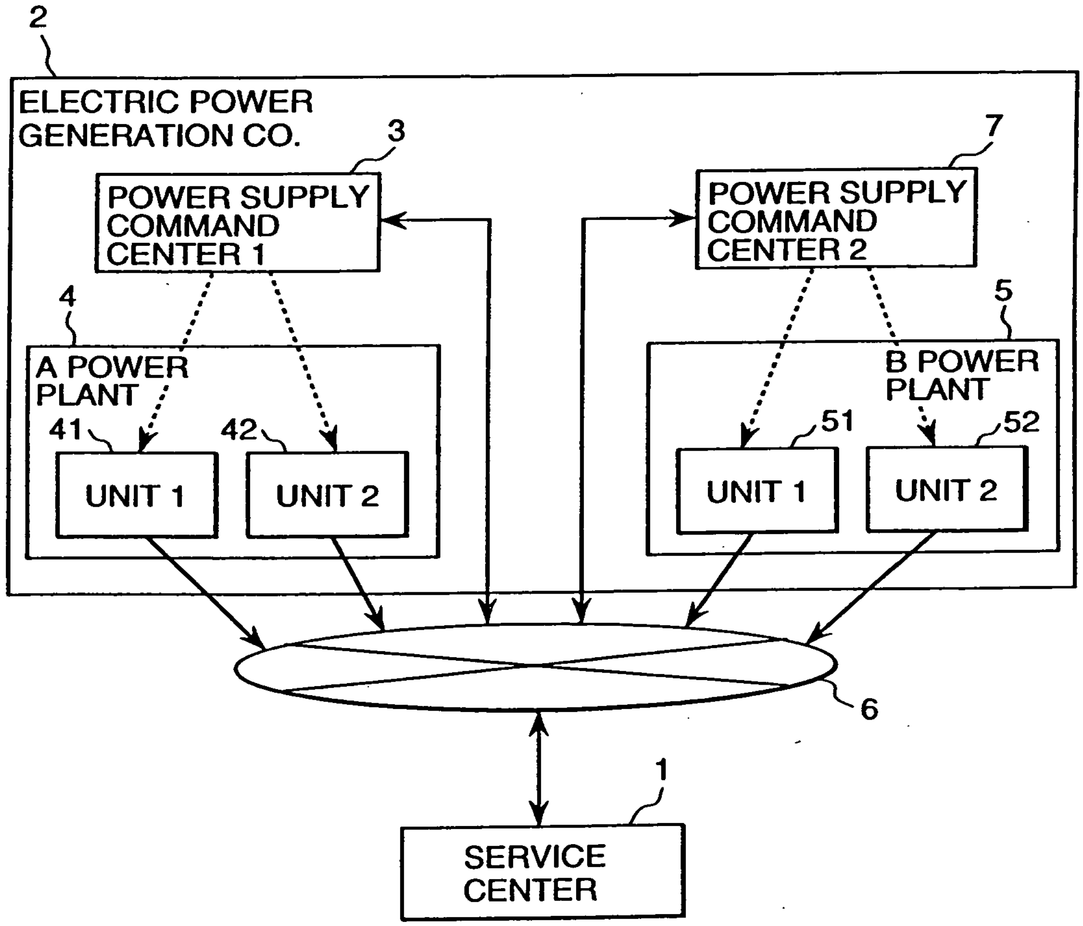
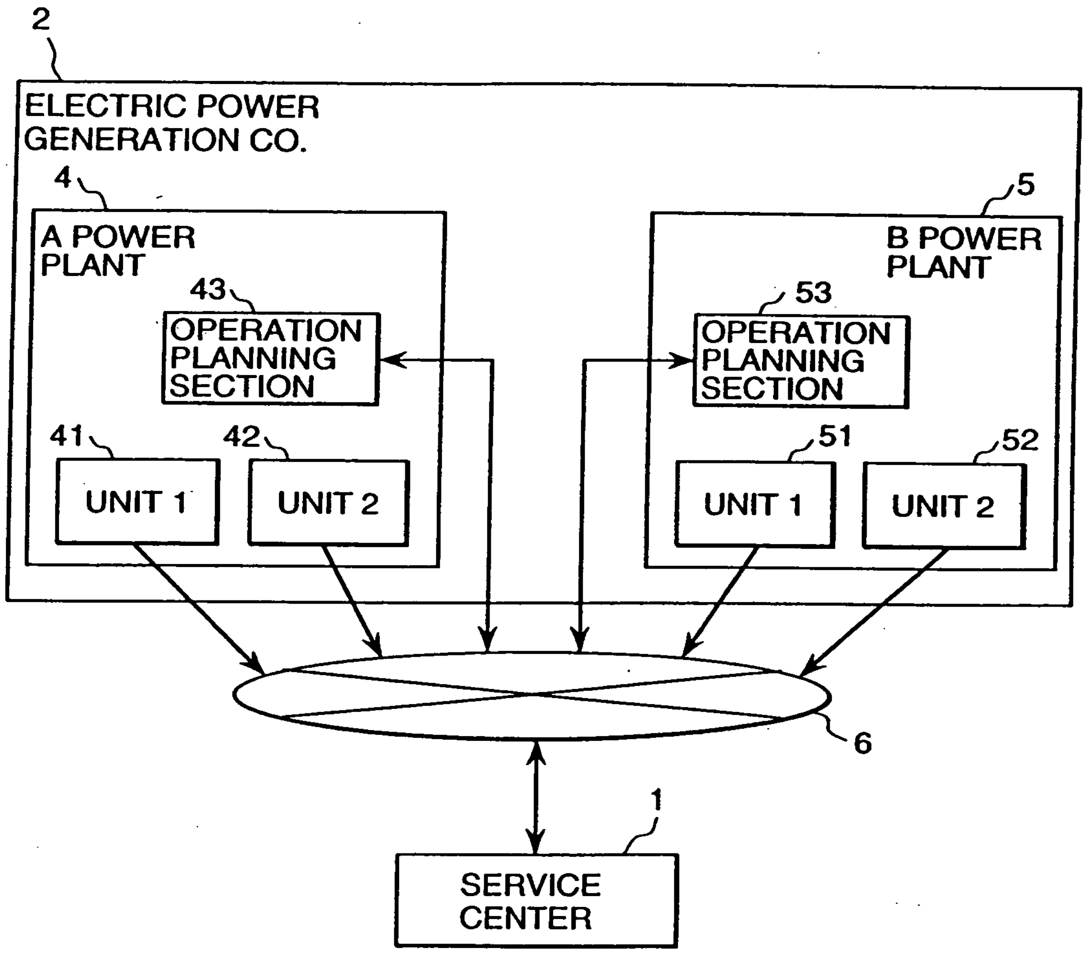

2
ELECTRIC POWER GENERATION CO.
3
POWER SUPPLY COMMAND CENTER 1
7
POWER SUPPLY COMMAND CENTER 2
4
A POWER PLANT
41
42
UNIT 1
UNIT 2
5
B POWER PLANT
51
52
UNIT 1
UNIT 2
6
1
SERVICE CENTER

FIG. 19


2
ELECTRIC POWER GENERATION CO.
4
A POWER PLANT
43
OPERATION PLANNING SECTION
41
UNIT 1
42
UNIT 2
5
B POWER PLANT
53
OPERATION PLANNING SECTION
51
UNIT 1
52
UNIT 2
6
1
SERVICE CENTER